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IS : 6064 - 1971
(Reaffirmed 2001)

Indian Standard

**SPECIFICATION FOR
SOUNDING AND SUSPENSION EQUIPMENT**

(Second Reprint MARCH 1996)

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BUREAU OF INDIAN STANDARDS
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Indian Standard

SPECIFICATION FOR SOUNDING AND SUSPENSION EQUIPMENT

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Indian Standard

SPECIFICATION FOR SOUNDING AND SUSPENSION EQUIPMENT

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 March 1971, after the draft finalized by the Fluid Flow Measurement Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Measurements of depth and velocity (also the collection of suspended sediment sample) are generally made in successive operations. Selection of a particular method of depth measurement and of suspension depends on depth of flow, velocity of current and the method of discharge observation whether by wading, from boat, from cable or from bridge. Except, when discharge measurements are done by wading, when both soundings (depth measurements) and placing of current meter at the point of measurement are done with the help of a wading rod, sounding and suspension equipment are essentially required.

0.3 This standard is one of the series of standards in the field of instruments used in stream gauging. Other standards in the series are:

IS : 3910-1965 Specification for current meters (cup type) for water flow measurement

IS : 3911-1966 Specification for surface floats

IS : 3912-1966 Specification for sounding rods

IS : 3913-1966 Specification for suspended sediment load samplers

IS : 3917-1966 Specification for scoop type bed material samplers

IS : 4073-1967 Specification for fish weights

IS : 4080-1967 Specification for vertical staff gauges

IS : 4858-1968 Specification for velocity rods

0.4 In the formulation of this standard considerable assistance has been derived from the Ganga Basin Water Resources Circle (Ministry of Irrigation & Power).

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with

IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the functional requirements, performance tests and materials to be used for manufacture of (a) sounding (by direct method), and (b) suspension equipment. With a view to providing guidance to the manufacturers, typical details of suspension equipment are given in Appendices A, B and C.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1191-1959† shall apply.

3. SOUNDING EQUIPMENT

3.1 The basic object of sounding is to obtain the correct vertical depth from water surface to bed, irrespective of the depth and velocity of flow. For this purpose (a) sounding rod or (b) wading rod (*see* Note 1) or (c) sounding line (*see* Note 2) is used depending on the velocity and depth of flow. In case of measurements either by sounding rod or wading rod, the rod should be held in a vertical position and in the case of measurements by sounding line, appropriate weights should be attached to keep it reasonably vertical.

NOTE 1 — As wading rods are also used for suspending the current meter, they are covered in 4.2.1.

NOTE 2 — As sounding line is essentially a cable (or chain) suspension type with attached sounding weights and that the measuring equipment are generally attached to this cable, it is covered in 4.2.2.

3.2 Sounding Rod — Sounding rod is a graduated rigid rod with a base plate and is used for measurement of depths up to 5 or 6 m in medium velocities (of 2 m/s). For details on sounding rod, reference may be made to IS : 3912-1966‡.

3.3 Sounding Weights — Sounding weights are added to keep the sounding line (or suspension cable) reasonably vertical. The higher the velocity and the greater the water depth, the heavier will be the weight required. The shape and size of the weights have an appreciable effect on the normal flow conditions in the channel and, therefore, on the accuracy of flow measurement. For details on sounding weights, reference may be made to IS : 4073-1967§.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms used in measurement of flow of water in open channels (*under revision*).

‡Specification for sounding rods.

§Specification for fish weights.

4. SUSPENSION EQUIPMENT

4.1 The basic requirements for taking observations in flowing water with the help of meter suspension equipment are the following:

- a) To place the measuring equipment (for example, current meter or sediment sampler) at the exact point of measurement without causing appreciable disturbance, irrespective of the depth of water and velocity of flow; and
- b) To suit the supporting devices like cable ways, bridges and boats or wading rod from which the measuring equipment is suspended.

4.2 Several types of suspension equipment have been developed to suit these basic requirements. These may be classified into two broad categories in **4.2.1** and **4.2.2**.

4.2.1 Rigid Rod Suspension Equipment — Rigid rod suspension equipment includes:

- a) hand operated suspension equipment like wading rod; and
- b) mechanically operated rigid rod suspension equipment, for example, rack and pinion.

4.2.1.1 These types of equipment have the merit that current meter or sediment sampler may be placed exactly at the point of measurement without any appreciable deflection from the vertical at which the observations are being taken, but these have limitations as well. Rigid rod suspension may be either hand operated or through mechanical means. Suspension equipment operated by hand are simple, may be manufactured with local resources, may be used up to 3 m depth and velocity of 2 m/s (except in the case of wading rods where the limits for the depth and velocity are 1 m and 1 m/s respectively), but are liable to personal errors.

4.2.1.2 Mechanically operated rigid rod equipment is preferable, because of the accuracy with which the measuring instrument may be placed at the point of measurement, but it is heavier, requires very careful installation with suitable counter-weights to ensure stability of the boat on which it is mounted and requires skilled handling. This type of equipment may be used up to 6 metre depth of water when velocities are up to 3 m/s. Beyond this operations become more difficult, if not risky. Such equipment cannot be used from high cable-ways and bridges, because of the inordinate length of the rigid rod required. However, the rigid rod suspension should be used, wherever possible.

4.2.2 Cable Suspension Equipment — Cable suspension equipment is generally used in measurement of deep streams where rigid rod suspension equipment cannot be used. It may, however, be used with necessary corrections in all conditions, to suspend the measuring equipment.

Depending on the depth and velocity encountered, suitable weights are attached to the cable suspension to keep the cable as vertical as possible. If the velocities are high and the depth great, the current-meter and weight are carried farther downstream so that the measured depth will be greater than the true depth and will therefore require corrections. In situations where large vertical angles are induced by high velocities, great depths, insufficient sounding weights, or any combination thereof, two separate corrections are required; an air-line correction for that part of the cable which is between the point of suspension and the surface of the water and a wet line correction for that portion of the cable which is in the water.

4.2.2.1 Where very large vertical angles are induced, weights of several hundred kilograms may become necessary to keep the cable, as vertical as possible. Such weights shall be handled and operated by power driven gauging reels and cranes, because under these conditions manually operated equipment would be entirely inadequate.

Cable suspension equipment includes:

- a) Hand line suspension, and
- b) Crane and gauging reel.

Hand line suspension is worked by hand, simple in design, and may be manufactured from local resources. It may be used with weights up to 15 kg and velocities up to 2 m/s but this type of suspension is liable to personal errors.

Crane and gauging reel suspension can be used under all conditions of flow, provided, suitable crane and gauging reel with sufficient weight is used. This type of equipment requires careful design, construction and installation, and skilled hands to use it.

5. FUNCTIONAL REQUIREMENTS

5.1 Rigid Rods for Sounding and Suspension

5.1.1 Sounding Rod — This should comply with the following requirements:

- a) Its weight should be as low as possible,
- b) It shall be straight and remain vertical during use,
- c) It should have sufficient strength to withstand the force due to flowing water without itself undergoing any significantly pronounced deflection,
- d) It shall not cause significant heading up of water due to its own obstruction,
- e) The smallest graduation should correspond to a centimetre, and
- f) It shall not penetrate into the bed of the channel.

5.1.2 Suspension Rod — In addition to the requirements of 5.1.1 (a) to (c) it should have suitable arrangement for attaching the measuring equipment in such a manner that there is no angular movement in the horizontal plane.

5.1.2.1 In case of mechanically operated rigid rod suspension equipment (*see* 4.2.1), they shall comply with the following additional requirements:

- a) Pawl and ratchet or other locking arrangement to hold the suspension rod in position, should be provided,
- b) The mechanical arrangement shall be such that the suspension rod may be raised or lowered easily,
- c) There shall be arrangement for fixing them to the boat or any other structure, and
- d) There shall be proper amount of counter-weight to ensure the stability of the boats.

5.2 Cable Suspension Equipment — These should comply with the following requirements:

- a) The cable should withstand the drag of the current on itself and on the suspended measuring equipment including additional weights and where necessary, to a reasonable extent of any debris that may strike or lodge on them.
- b) The cable shall have sufficient strength to sustain the weight of the measuring equipment suspended and of the weights to be used to keep it vertical, without undergoing any significantly pronounced elongation under the strain of weight. It shall have a suitable attachment for suspending the measuring equipment.
- c) The cable shall have an insulated conductor to be used for transmission of the electrical impulses due to revolution of the current meter to the counting devices.
- d) The cable shall be smooth and flexible, so that it may take turns without any permanent bends or twists, which would affect its usability and length.
- e) When supplied for use as hand line, the cable should have a suitable covering to prevent hurting to the hand.
- f) The gauging reel drum shall be preferably of such diameter that one revolution of the winding delivers 0.30 metre of cable, the length unwound being measured on an attached counter, reading in metres, decimetres and centimetres. The drum shall be able to accommodate the specified length of the cable in single layer. There shall be an arrangement to ensure the winding and unwinding of the cable on the drum in single layer only, without overlapping.

There shall be a pawl and ratchet or any other locking arrangement to hold the drum at any desired position. There shall be a plug and socket arrangement to connect the gauging reel to the revolution counter or any other instrument. The gauging reel shall be able to be operated by hand for lowering or raising the measuring equipment and weights attached without any difficulty. There shall be arrangement for fixing the gauging reel to the supporting device used for discharge measurement, like cable car used on a cable way, crane used on a bridge or A-frame used on boats, etc.

- g) The cable cars shall be of adequate strength and proper design to carry the observers and measuring equipment to any desired point on the cable way. They shall also provide safety and reasonable comfort for the observers while they are making discharge measurements, and shall afford adequate means of support for the gauging reel whenever it is required to be attached.
- h) The crane shall be of adequate strength to support the gauging reel, the measuring equipment and the weights attached to keep the cable vertical. It shall be of proper design to enable the measuring equipment to be lowered or raised in a vertical plane sufficiently away from the structure without fouling with the structure, and to enable its movements from point to point when used on a bridge. It shall have a protractor to measure the deviation of the cable from the vertical. It shall have proper counter-weights to ensure its stability while in use. It should be collapsible so that it may be easily carried away after use.
- j) As cranes are heavy, A-frame is used, which is sometimes fixed on boats, should be of adequate strength to support the gauging reel, the measuring equipment and the weight attached to keep the cable vertical. It should be of proper design, to enable the measuring equipment to be lowered or raised in a vertical plane sufficiently away from the boat without fouling with it. It should have a protractor to measure the deviation of the cable from the vertical. It should be easily fixed on the boat in such a way, that when not in use, it may be collapsed to rest on the boat without causing obstruction. It shall have adequate arrangements for fixing gauging reel on it and for carrying the gauging cable over it to raise or lower the measuring equipment.

5.3 Sounding Weights

5.3.1 The weights shall comply with the following requirements:

- a) The weights are required to provide protection to the current-meter when it is being lowered in water. Therefore, its size should be such as to shield the current meter cups and body;

- b) They shall be stream-lined to offer least obstruction to water; and
- c) They shall be provided with vanes for orienting them correctly in the direction of flow.

6. PERFORMANCE TESTS

6.1 Rigid Rods for Sounding and Suspension — The following tests shall be satisfied:

- a) When the rod is simply supported over the span (length of the rod) and subjected to central concentrated load of 20 kg, the deflection shall not exceed 5 mm;
- b) The rigid rod shall have such a section as to cause minimum heading up of water (not more than 5 cm at the maximum specified velocity of 3 m/s); and
- c) When used for sounding, it shall not penetrate more than 0.5 cm into the bed under a vertically applied load of 50 kg (besides its own weight).

6.2 Cable Suspension — The following tests shall be satisfied:

- a) The gauging reel cable shall have a breaking strength of not less than five times the total weight it has to support; and
- b) The hand line or gauging reel cable shall not undergo any significant change in its length, by more than ± 0.5 percent, when dry or in wet conditions or loaded.

7. MATERIALS

7.1 Materials to be used in manufacture of both the rigid rod and cable suspension equipment shall conform to the following requirements:

- a) The material used shall be suitable for stream gauging purposes and shall be treated to be rust proof;
- b) The material used shall be as light in weight as possible (except in the case of sounding weights for which material of specific gravity greater than 7.5 is required), yet of adequate strength to support the rigid rod or gauging reel, measuring equipment and weights attached to keep the cable vertical; and
- c) The conductor with the cable, shall be properly insulated to avoid any leakage of current.

8. GRADUATIONS

8.1 The rigid rod shall be graduated in metres, decimetres and centimetres (for velocity measurements these are sometimes graduated in 0.6 decimetre

units as to indicate the suspension point along the depth straight away). The graduations should be easily discernible under working conditions and be able to withstand water action and not be easily rubbed away by the abrasion caused by upward or downward motion of rod against the supporting structure when in use. These graduations should be accurate and should be checked with an accurate steel tape.

8.2 Similarly hand line or gauging reel cable shall be graduated in metres, decimetres and centimetres. The same precautions as in **8.1** shall be taken.

9. MARKING

9.1 Each meter suspension equipment shall bear the manufacturer's name and date of manufacture. They shall be marked with ISI Certification Mark.

9.2 BIS Certification Marking

The product may also be marked with Standard Mark.

9.2.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

A P P E N D I X A

(Clause 1.1)

TYPICAL EXAMPLES OF RIGID ROD SUSPENSION EQUIPMENT

A-0. GENERAL

A-0.1 For rigid rod suspension, the following suspension arrangements are most commonly used:

- a) Hand operated rigid rod suspension like wading rod, and
- b) Mechanically operated rigid rod suspension like rack and pinion.

A-1. HAND OPERATED RIGID ROD SUSPENSION

A-1.0 According to convenience and availability of material, the rigid rods are made of metal, or wood or of bamboo, or of any other light straight and rigid material capable of withstanding the strain due to velocity and depth of flowing water. Such rods are generally used in depths up to 3 m and velocities up to 2 m/s.

A-1.1 Metallic Rigid Rod — In case of metallic rods, these are made of 1 m long pieces of about 20 mm diameter. One end of the rod is threaded for about 20 mm, and the other end is threaded from inside for about 20 mm length, in such a way that one end of the rod piece can fit in the other end of the second rod piece (*see* Fig. 1A). In the lower end of the bottom rod a slot approximately 145 mm long is made having 3 holes at 60 mm interval for fixing the suspension rod of the current meter as shown in the Fig. 1. The other end of the bottom rod is threaded for about 20 mm to be fitted to the other rod piece.

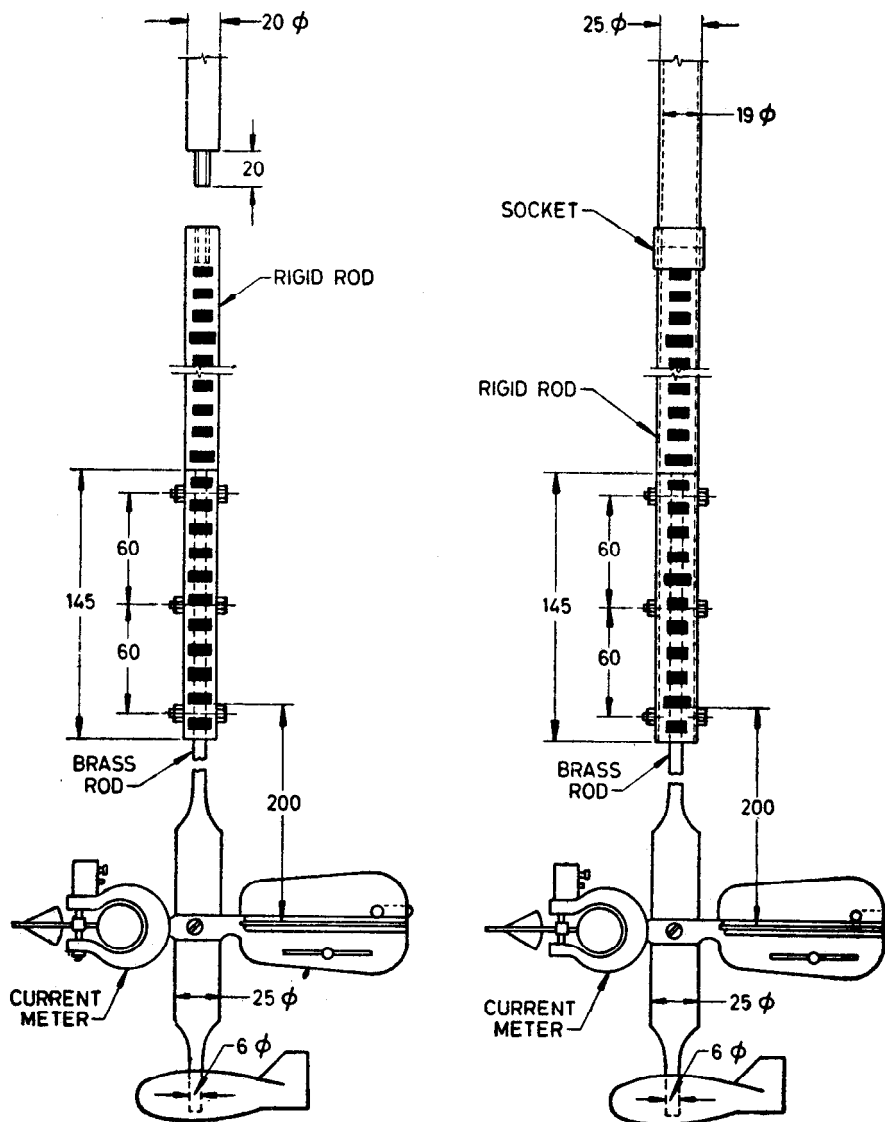
A-1.1.1 Instead of a rigid metallic rod a pipe and socket arrangement can be conveniently used (*see* Fig. 1B). Pipe pieces of 1 m length with about 19 mm inside dia and 25 mm outside dia having external threads on both ends and joined together with sockets are generally used with the same device for suspending the current meter.

A-1.1.2 The metallic rod is given an anti-corrosive finish over its entire length. For the sake of convenience the entire length of the rod is graduated at 0.6 times of metres, decimetres and centimetres with enamel paint or by etching and painting with black and white paints to read directly the suspension point corresponding to the depth. The number to indicate metres and decimetres and their graduations should be marked conspicuously in red enamel paint, the graduations shall be measured from the axis of the current meter as shown in Fig. 1A and 1B.

A-1.2 Wooden and Bamboo Rigid Rods

A-1.2.1 Wooden or bamboo rigid rods (*see* Fig. 1C) may also be used for suspending the current meter. These are reasonably strong and lighter to use as compared to solid metallic rods. When bamboo is proposed to be used, care should be taken to select long, straight and strong bamboos of adequate girth say of about 40 mm diameter. The bamboo should not be green or cracked. The wooden rods should be made of strong, completely seasoned wood, circular in shape, with about 40 mm diameter and very smooth over its entire surface.

A-1.2.2 The arrangements for fixing the current meter to the rod is shown in Fig. 1C. The wooden or bamboo rigid rod should be correctly and clearly graduated at 0.6 times of metres, decimetres and centimetres with

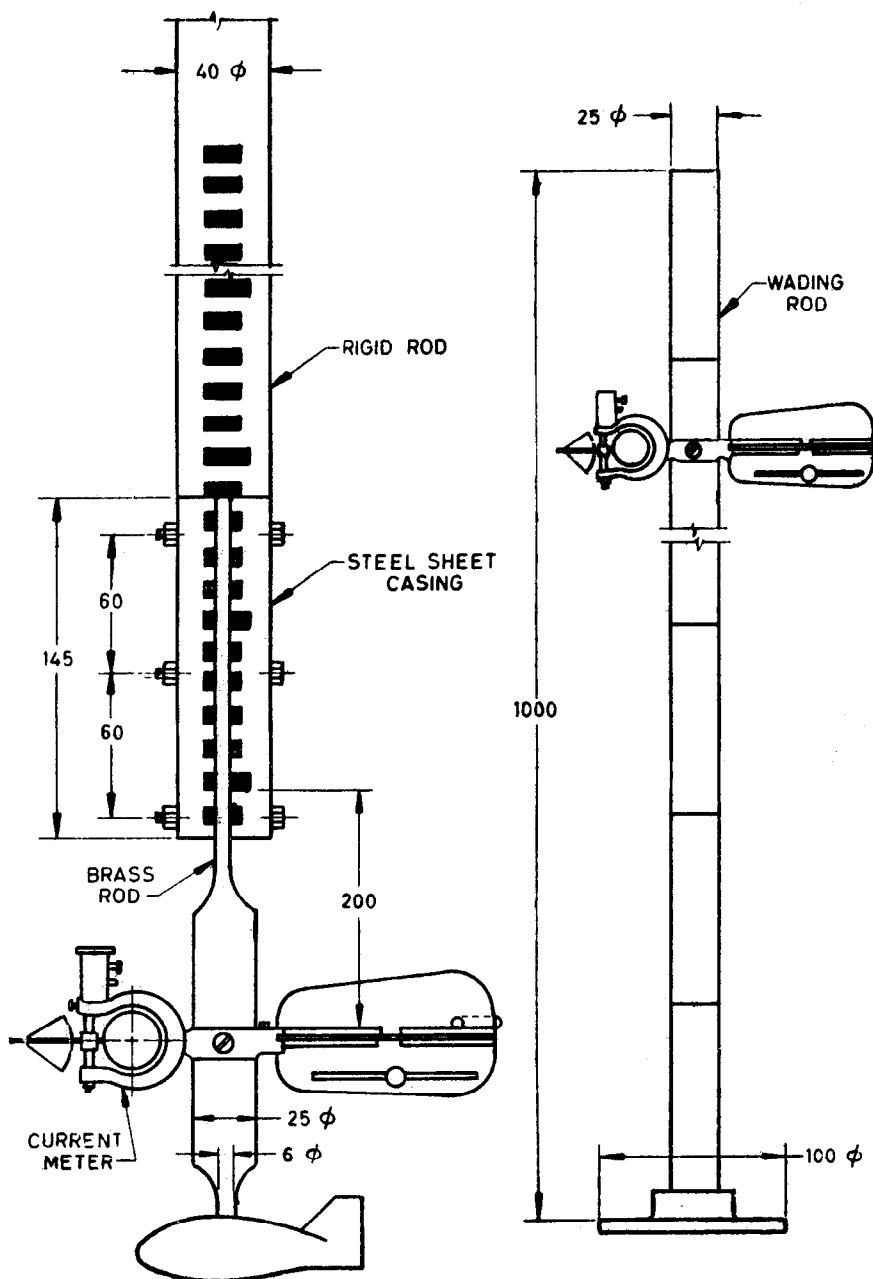


IA Solid Type (Metallic)

IB Hollow Type (Metallic)

All dimensions in millimetres.

FIG. 1 HAND OPERATED RIGID ROD — *Contd*



IC Bamboo or Wooden Type

ID Wading Rod

All dimension in millimetres.

FIG. 1 HAND OPERATED RIGID ROD

enamel paint, or by carving and painting them with black and white paint to read directly the suspension point corresponding to the depth. The numbers in metres and decimetres and their graduations should be marked conspicuously in red enamel paint. The graduations shall be measured from the axis of the current meter as shown in Fig. 1C.

A-1.3 Wading Rod — Instead of suspending the current meter from a support, the measurements are taken by wading across the stream. In such cases the wading rod (*see* Fig. 1D) (of rust proof metal) is provided at the bottom with a 100 mm dia circular base plate with a flange to hold the rod in a vertical position and to prevent its sinking in the bed. The current meter may be fixed at any desired height by sliding it along the rod. The diameter of the rod shall correspond to that of the current meter suspension rod which is 25 mm, and the length will be generally 1 m and it should be engraved in decimetres and centimetres.

A-2. MECHANICALLY OPERATED RIGID ROD

A-2.0 General — In this arrangement, the rigid rod is raised or lowered through mechanical devices incorporating a rack and pinion arrangement. There are two such arrangements in use depending on the materials used and are generally called:

- a) rack and pinion (steel), and
- b) mechanically operated rigid rod (aluminium).

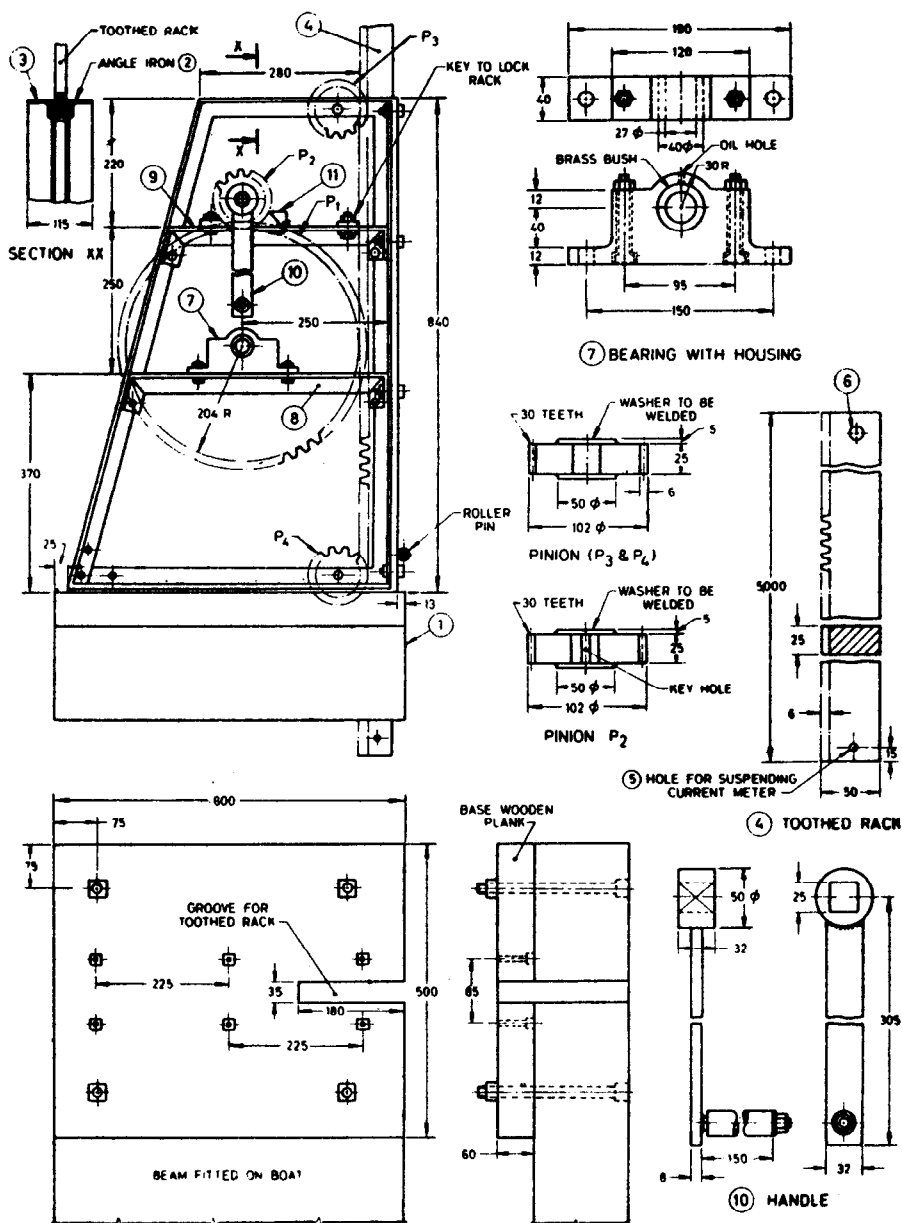
A-2.1 Rack and Pinion (Steel)

A-2.1.1 General Description — The whole assembly and details of its various parts are shown in Fig. 2. Its main parts are the following:

- a) Wooden base and mild steel angle iron frame,
- b) Mild steel rack, and
- c) Raising or lowering arrangement.

A-2.1.1.1 Wooden base and M. S. angle iron frame — The wooden base (1) on which the mild steel angle iron frames (2) and (3) are fixed is approximately 600 × 500 mm in size and 60 mm in thickness. The mild steel angle iron frame will be composed of two such frames approximately 40 × 40 × 6 mm each to a height of about 840 mm. The joints of the frames may be either welded or fixed with bolts and nuts. Both these frames (2) and (3) are fixed to the wooden base (1) by bolts and nuts at spacings of about 225 mm as shown in Fig. 2.

A-2.1.1.2 Mild steel rack — It is 5 metres long and about 50 × 25 mm in size, having teeth on its one side with 10 mm pitch (4). At its bottom end there will be a hole (5) of about 12 mm diameter for holding the current meter. At the top, there will be a mild steel pin (6) to prevent its sliding down completely under its own weight.



All dimensions are in millimetres and approximate.
FIG. 2 TYPICAL DETAILS OF RACK AND PINION

A-2.1.1.3 Raising and lowering arrangement for mild steel rack (4) — This arrangement consists of four mild steel toothed pinions P_1 , P_2 , P_3 and P_4 . Pinion P_1 is about 408 mm in diameter and will have 120 teeth in all. It will be fixed between the frames (2) and (3) through cast iron bearings and their housing (7). The cast iron bearings with housings (7) will be fixed to the mild steel angle iron frame members (8) of the two frames (2) and (3) with the help of mild steel bolts and nuts as shown in Fig. 2. Similarly pinion P_2 will be fixed to the member (9) of the frame (2) and (3). Pinions P_2 , P_3 and P_4 will be about 102 mm in diameter with 30 teeth in each. Pinion P_3 and P_4 will be fixed respectively at top and bottom members of the mild steel angle iron frames (2) and (3) as shown in Fig. 2 to serve as guides to the mild steel rack (4).

A-2.1.1.4 For lowering or raising the mild steel rack (4) the pinion P_2 will be rotated with the help of the handle (10) according to the details shown in Fig. 2. Pinion P_2 will impart rotation to pinion P_1 which in turn will raise or lower the mild steel rack (4). The current meter can then be placed at the desired depth. A pawl and ratchet arrangement (11) will be fixed to the pinion P_1 to hold it at the desired point. To stop lateral movement of the mild steel rack (4) mild steel guides should be provided.

A-2.1.2 The following are the precautions for satisfactory operation of the rack and pinion:

- a) The rack and pinion is a heavy equipment. It should be very securely fixed to a wooden beam fitted on the boat. The boat should also have suitable counter weights fixed to the other end of the wooden beam for balance.
- b) The whole assembly should be so fixed to the wooden beam that the rack moves in a vertical plane, and away from the disturbance caused by the boat.
- c) The current meter should be securely fixed to the rack so that there are no chances of its getting loose and then lost.
- d) The rack should be graduated to read 0.6 of the depth directly, the readings being taken from the centre of the bucket axis of the current meter.
- e) The rack should be raised or lowered gradually and not with jerks. Pawl and ratchet arrangement should always be used to prevent unwanted movement.
- f) While not in use, the bottom end of the rack should be above water surface when the boat is moving.
- g) The rack may be conveniently removed and safely kept away, when not in use.

A-2.2 Mechanically Operated Rigid Rod (Aluminium)

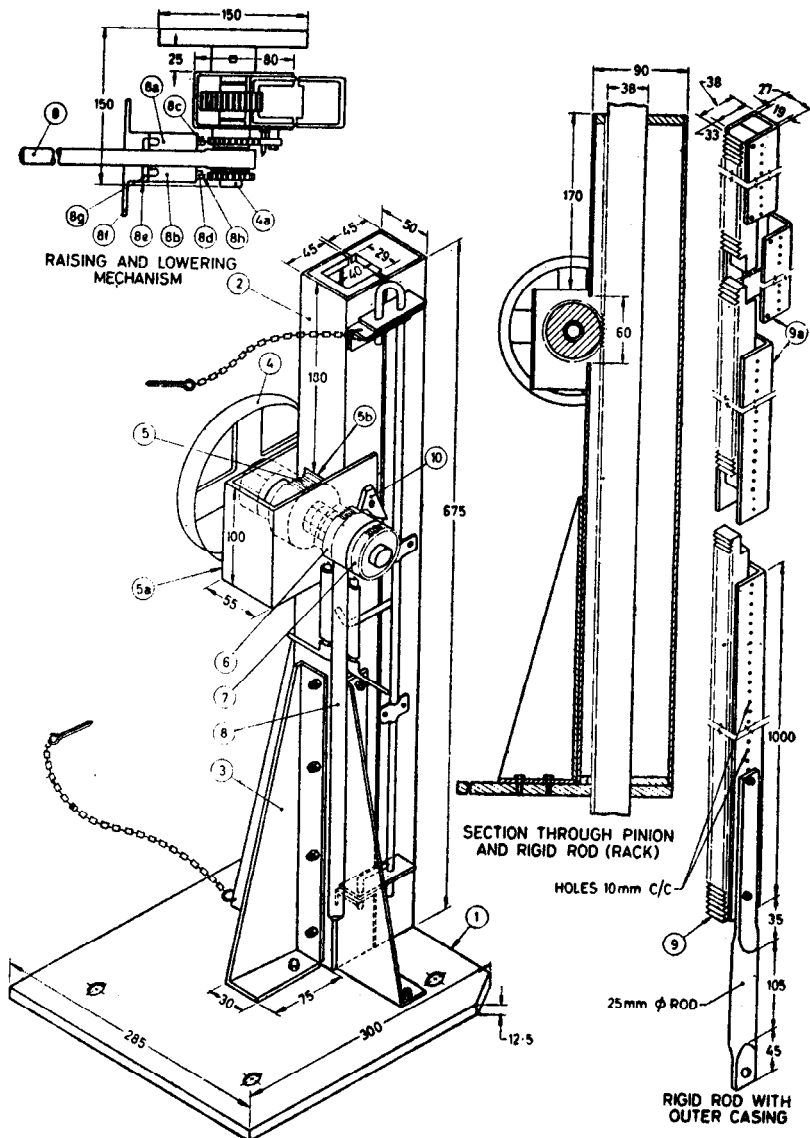
A-2.2.1 General Description — The mechanically operated rigid rod suspension arrangement has been devised to make the arrangement lighter and simpler than the conventional rack and pinion. It may be fitted both to light as well as big and heavy boats. Its weight being small, counterweights to keep the boat balanced, are generally not required or negligible. This has been possible by making most of its parts of aluminium alloys instead of mild steel, and by reducing the size of pinions for the same efficiency. The whole assembly and details of its various parts are shown in Fig. 3. Its main parts are the following:

- a) Base plate casing and supporting plates,
- b) Rigid rod (rack), and
- c) Raising or lowering mechanism arrangement.

A-2.2.1.1 Base plate casting and supporting plates — The base plate (1) is about 300×285 mm in size, made of an aluminium alloy and of 12.5 mm in thickness.

The aluminium casing (2) is composed of two channels about 45 mm deep and 50 mm wide, and 675 mm in height each. One of these channels is fixed with bolts and nuts to the base plate with three supporting aluminium plates (3) of the shape shown in the Fig. 3. To this channel, the second channel is hinged on one side, and on the other side it is attached through a sliding tower bolt. Both these channels, thus form the casing (2) for housing the rigid rod (rack 9), inside it. The outer channel may be opened or closed at will, because of the above arrangement, to insert or take out the rigid rod (rack 9). Two mild steel channels are fixed at the top or bottom of the two casing channels (as shown in Fig. 3) to form an opening of about 40×29 mm for the rigid rod (9) to be moved up and down. The fixed channel has got an opening (5b) of about 60×22 mm at 180 mm from upper end for movement of pinion (5).

A-2.2.1.2 Rigid rod (rack 9) — The rigid rod (9) is made of 10 mm square steel rod having teeth on its one side. The rod is encased in a channel shaped aluminium outer casing of about 33×27 mm size and 1 metre long as shown in Fig. 3. The length of the steel rod will be 4.5 m made in three pieces of 1.5 m each. One piece will be fixed to the outer casing as shown and the other two pieces are added, when required for greater depths. Holes 10 mm apart will be made in the outer casing (9a) to adjust the lowering or raising of the rod to the required depth. To the lower end of the rod, suspension rod of the current meter is attached with the help of bolts and nuts to suspend the current meter. Graduation markings are engraved from the central axis point of the current meter buckets.



All dimensions are in millimetres and approximate.

FIG. 3 TYPICAL DETAILS OF A RIGID ROD (MECHANICALLY OPERATED)

A-2.2.1.3 Raising and lowering mechanism — Its details are shown in Fig. 3. The main parts of this arrangement are the following:

- a) *Mild steel bolt (4a)* — is about 150 mm long and 13 mm in diameter,
- b) *Mild steel toothed pinions (5), (6) and (7)* — The mild steel toothed pinion (5) is of 60 mm dia and 21 mm width. The mild steel pinions (6) and (7) have got teeth in the opposite direction. These are of 50 mm dia and 6 mm width,
- c) *Aluminium handle (8) with arrangements to engage pinions (6) and (7)* — The aluminium handle (8) has got a round sleeve of about 19 mm width on its one end. This sleeve may be screwed to the bolt (4a). To this end of the handle, two sleeves (8a) and (8b) about 67.5 mm long are welded on its either side. In the outer end of these sleeves two slots are cut. Two mild steel rods (8c) and (8d) of about 105 mm length pass through the holes in the sleeves and these rods have one cut edge (8h) screwed on their one end, to engage the pinions (6) and (7). On the other end, a sleeve head (8e) with a small handle (8f) and a tongue (8g) to fit in the slots in the sleeves (8a) and (8b) is screwed. The mild steel rods (8c) and (8d) are passed through the hole in the sleeves (8a) and (8b) and thereafter the cut edge and the sleeve head are screwed on to it, in such a manner that the tongue of the sleeve head is fully inserted in the slot in the sleeve (8a) and the cut edge can fully engage the teeth on the pinions (6) and (7). To disengage the teeth on the pinions (6) and (7), the cut edge end of the mild steel rod (8c) or (8d) is lifted by the handle (8f) in the sleeve head (8e), so that the tongue (8g) is lifted out of the slot in the sleeve (8a) or (8b) and is kept in the other slot in the sleeve (8a) and (8b) which is shorter in length,
- d) *Aluminium hand wheel (4)* — is approximately of 150 mm dia with 15 mm dia round rim, and 25 mm long boss on its one side. This wheel is fixed to the mild steel bolt (4a) by a bolt passing through the hole in the sleeve,
- e) *Mild steel box (5a)* — is about 80×55 mm and 100 mm high of 3 mm thickness, is open on one side. It may be fixed to the casing (2) by bolts and nuts so that its top is 170 mm from the top of the casing (2).

A-2.2.2 Assembly of the Raising and Lowering Arrangement — Pinion (7), handle sleeve (8) and pinion (6) are first of all screwed to the mild steel bolt (4a) on its head side separated by loose sleeves pushed in between as shown in Fig. 3. The mild steel bolt is then passed through one of the holes in the side of the box (5a). Then the pinion (5) is screwed to the bolt

separated by a loose sleeve from the box side in such a manner that it may freely rotate in the slot (5b) in casing (2) when the box is fitted to it. After slipping in a loose sleeve, to ensure that the pinion (5) is securely fixed inside the box, the bolt is passed through the hole in the other side of the box. To this end, the hand wheel (4) is fixed with a bolt. The box (5b) is then fixed with bolts and nuts to the casing (2). A pawl and ratchet arrangement (10) is fixed to the box, to engage pinion (6) in such a manner that the movement is controlled.

A-2.2.3 Operation — The rigid rod (rack 9) is inserted in the casing (2), and its outer cover closed and secured by the sliding bolt. The rigid rod is so fixed that it can pass through the slot in the base plate, easily without fouling with sides, and its toothed edge may engage the teeth of pinion (5). The movement to pinion (5) may be given either by rotating the hand wheel (4) by hand or by engaging the pinion (6) or (7) by arrangement in the handle (8). Pinion (6) is used for lowering and pinion (7) for raising, these having teeth in the opposite direction. For precise placement of the rigid rod (9), it has got holes at 10 mm apart. An iron nail is fixed with a brass string to the top end of casing (2). This iron nail is inserted in the holes in the rod (9) to adjust its exact placement.

A-2.2.4 Precautions Necessary While Using the Rigid Rod Suspension Arrangement

- a) The whole assembly should be fixed to the boat on a platform preferably at its side at a minimum distance of 1 m, so that the movement of the rigid rod is unrestricted in a vertical plane and away from the disturbance caused by the boat.
- b) If necessary, sufficient counter-weights should be placed to ensure stability of the boat.
- c) The current meter should be securely fixed to the rigid rod, so that there are no chances of its getting loose and lost.
- d) The rack should be graduated to read 0.6 of the depth directly, the readings being taken from the centre of the bucket of the current meter.
- e) The rack should be raised or lowered gradually and not with jerks. Pawl and ratchet arrangement should always be used to prevent unwanted movement.
- f) While not in use, the bottom end of the rack should be sufficiently above water surface when the boat is moving.
- g) The rack should be removed and kept away, when not in use.

APPENDIX B

(Clause 1.1)

TYPICAL EXAMPLES OF CABLE SUSPENSION EQUIPMENT

B-0. GENERAL

B-0.1 Cable suspension equipment includes the following:

- a) Hand line suspension arrangement, and
- b) Crane and gauging reel suspension arrangement (details of gauging reel are covered separately in Appendix C).

B-1. HAND LINE SUSPENSION EQUIPMENT (CABLE)

B-1.1 Parts of the Suspension Equipment — The details are shown in Fig. 4. Its main parts are the following:

- a) Suspension cable (1),
- b) Terminal connections (2), and
- c) Suspension hook (3).

B-1.1.1 Suspension Cable (1) — This is an insulated, usually rubber covered waterproof, hand service, two conductor cable, about 10 mm in diameter. The usual length supplied is generally 12 m. This should be a steel cable having a breaking strength of not less than 100 kg. For heavier weights, extra strong steel wire suspension is required, but it is recommended that a gauging reel should be used in that case.

B-1.1.2 Terminal Connections — At upper end of the suspension cable, there is double contact plug connector (2a). It is used to connect the cable to a headphone or a counter through the battery. On the lower end, both the conductor cables carry brass contact points (2b) to be connected to the current meter.

B-1.1.3 Suspension Hook (3) — The suspension cable (1) is formed into a loop round a metal ring near its lower end, the two loose portions being tied down by a thick and strong twine, as shown in Fig. 4. In this loop (3a) the meter suspension hook is suspended. The meter suspension hook (3) is made of brass and is nickel plated. It is of the shape as shown in Fig. 4, having a ring (3b) at the top and an open hook (3c) at the bottom. The opening in the hook may be opened by a small rod (3d) worked with a handle (3e). This remains in closing position always under spring (3f) power. It may only be opened temporarily for inserting or taking out the current meter in or from the hook, by forcing the rod handle upwards

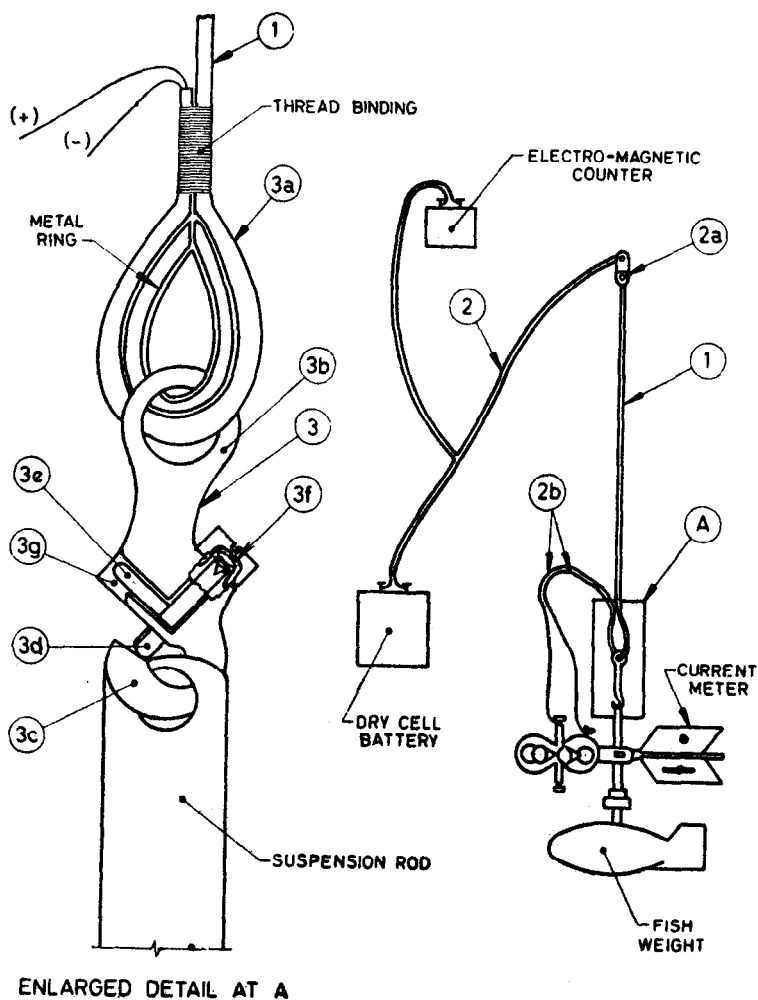


FIG. 4 TYPICAL DETAILS OF CABLE SUSPENSION ARRANGEMENT

against the spring. As soon as the force is removed, the opening in the hook is automatically closed. When in closed position, the handle of the rod is also pressed down in a slot (3g) in the hook (3) body, so that it is not accidentally pressed upwards.

B-1.1.4 The connections of the suspension cable assembly to the current meter, battery and headphone or counter are shown in Fig. 4 and the precautions to be taken are as given below:

- a) The cable should be kept as vertical as possible while in use by using suitable weights fixed to the current meter.
- b) The electric connections should be made with care, so that there is no chance of short circuiting.
- c) It should be ensured that after inserting the current meter in the cable hook, the hook opening is properly closed.
- d) It will be advantageous, if as an additional precaution, a string is separately attached to the current meter, so that there are no chances of losing the current meter, even if the cable hook accidentally gets opened.

B-2. CRANE AND GAUGING REEL SUSPENSION EQUIPMENT

B-2.0 There are two types of cranes and gauging reel suspension equipment as given below:

- a) *A*-crane and gauging reel, and
- b) *A*-frame and gauging reel.

B-2.1 *A*-Crane and Gauging Reel

B-2.1.1 General Description — The whole arrangement is shown in Fig. 5 and the main details of *A*-crane are shown in Fig. 6. Its main parts are the following:

- a) Base frame,
- b) Body frame (collapsible),
- c) Boom frame (collapsible), and
- d) Suspension pulley arrangement.

B-2.1.1.1 Base frame — It is a rectangular frame about 920×740 mm made of aluminium angles about $38 \times 38 \times 4.8$ mm size, jointed to each other by bolts and nuts. Four rubber typed wheels are fixed at the bottom and there is a handle attached for shifting the *A*-crane from place to place. Battery, as well as counterweight are placed on this base frame, at places earmarked for these, as shown in Fig. 5.

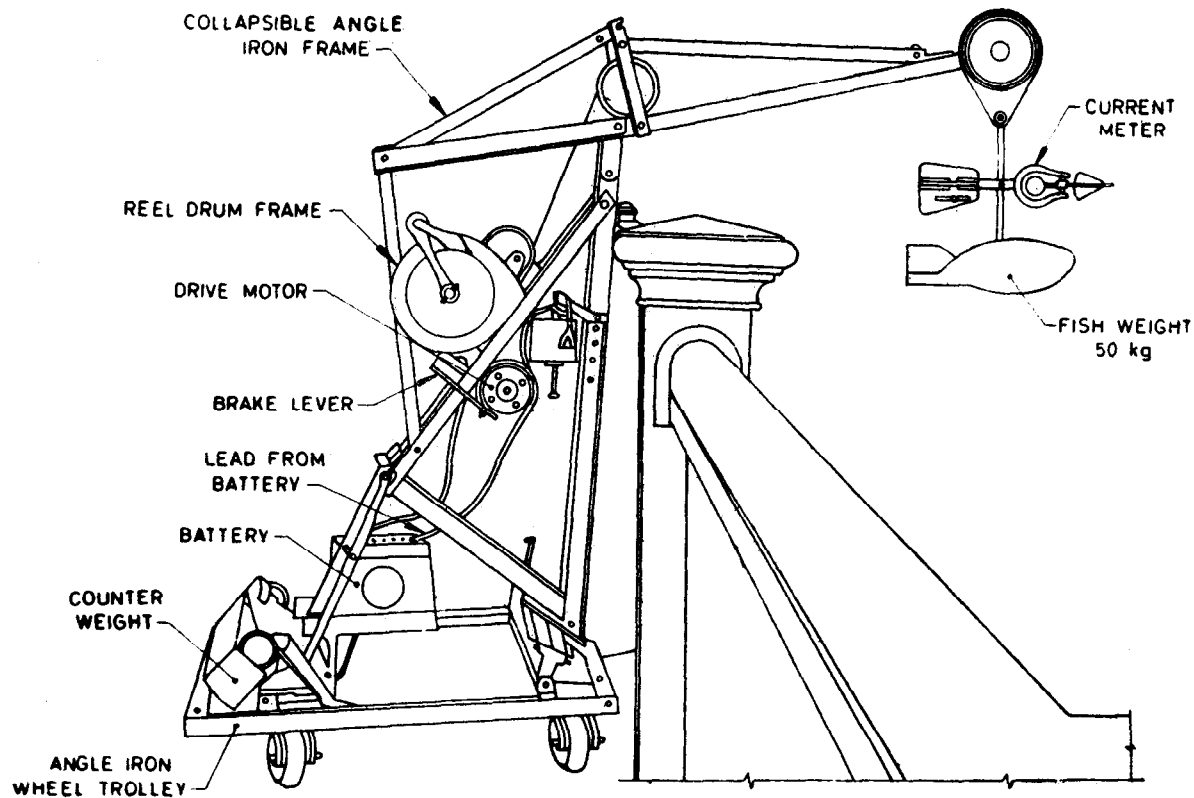


FIG. 5 A-CRANE AND GAUGING REEL SUSPENSION ARRANGEMENT

B-2.1.1.2 Body frame (collapsible) — It is made of three aluminium frames joined together by bolts and nuts as shown in Fig. 5 and 6. The vertical frame is made of two aluminium angles (2) and (4) joined together with plate (9) and screwed. Its details are shown in Fig. 6. Similarly the other vertical frame is made of aluminium bars (17) as shown in Fig. 6. The third inclined frame is made of aluminium angles (7) and plate (12) as shown in Fig. 6 in detail. On this frame, the gauging reel assembly and its motor are fixed on the plate (12) as shown in Fig. 5.

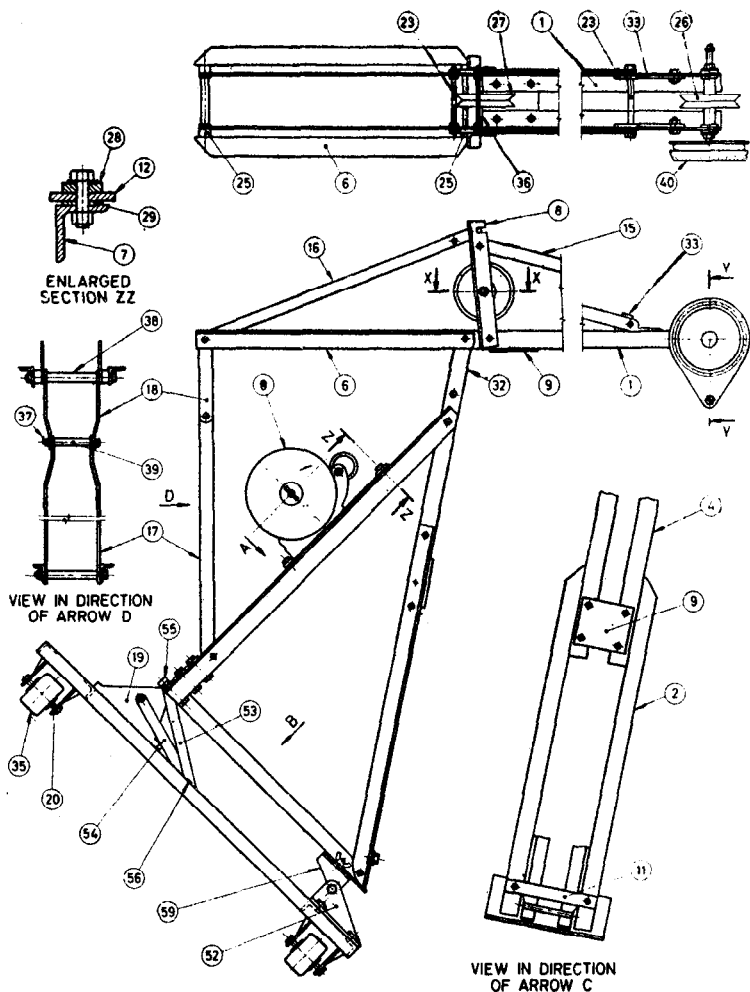
This body frame is fixed to the base frame through plates (53), (54) and (59) as shown in Fig. 6. On the upper side it is fixed to the boom frame through bolts and nuts as shown in Fig. 6.

B-2.1.1.3 Boom frame (collapsible) and suspension pulley arrangement—The boom frame is made of aluminium angles (1) and (6) and bars (15) and (16) as shown in Fig. 6. Both the aluminium angles are provided with hooks just near the front, in which bars (15) are hooked in the extended portion. Similarly bars (16) are hooked in notches provided in the aluminium angles (8) in the extended condition. The aluminium angle (8) connects angle (1) and (6) with the bars (15) and (16) and also carries the brass sheave (27) at the centre. The front end of this assembly of angles and bars carries the aluminium sheave (26) provided with an aluminium protractor circle (40) for measuring the vertical angle made by the reel, while the instrument is suspended.

B-2.1.2 Operation — The gauging reel is carried from its drum to the brass sheave (27) and passed over aluminium sheave (26). To the end of this gauging reel the shackle to hold the current meter is fixed. The gauging reel drum may be rotated either by a handle, or by an electric motor worked with battery. By rotating the drum, the current meter is lowered or raised. Suitable weights are attached below the current meter, to keep the reel vertical. Any deviation is measured on the protractor (40). The distance to which the current meter is lowered is recorded on the counter attached to the drum.

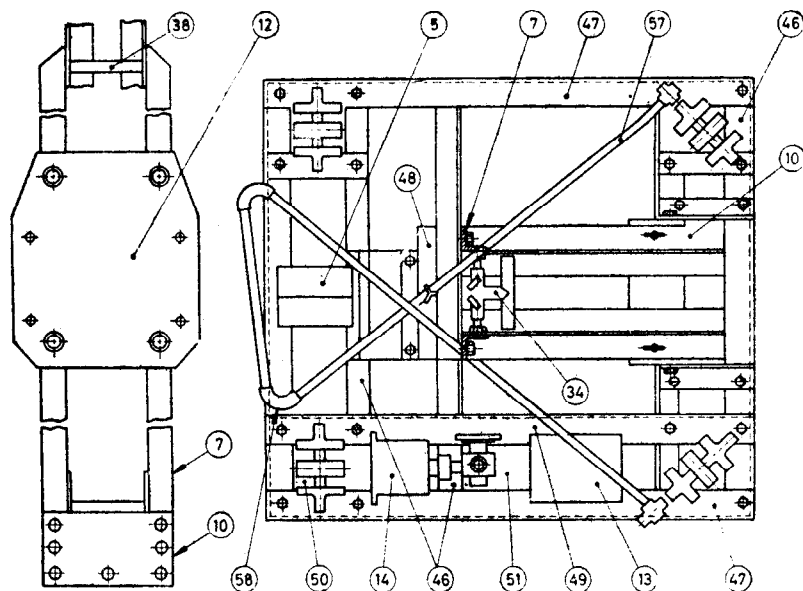
B-2.1.3 The precautions necessary while using the A-crane and gauging reel are given below:

- a) When used on a boat, its wheel should be so fixed by some suitable arrangement that the crane does not roll from place to place. Suitable counter-weights should be provided for keeping the boat balanced;
- b) The A-crane should ordinarily be used only on big boats and launches;
- c) While using from a bridge, counter-weights are still necessary for proper balance;

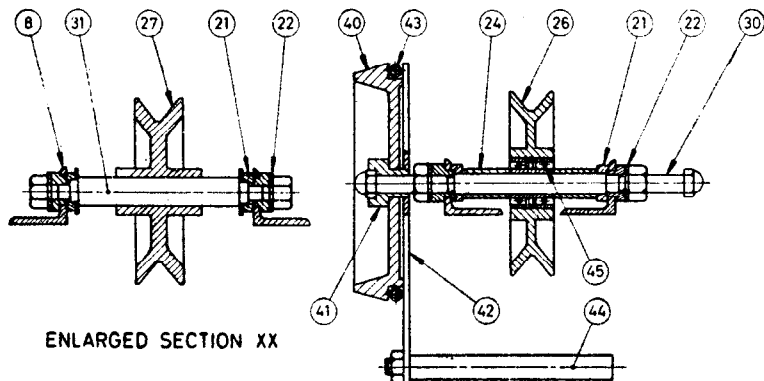


Part No.	Part Name	Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
1.	Angle	8.	Angle	16.	Plate	24.	Spacer
2.	Angle	9.	Plate	17.	Plate	25.	Spacer
3.	Gauging reel assembly	10.	Plate	18.	Plate	26.	Sheave
4.	Angle	11.	Plate	19.	Plate	27.	Sheave
5.	Angle	12.	Plate	20.	Spacer	28.	Insulator
6.	Angle	13.	Plate	21.	Insulator	29.	Insulator
7.	Angle	14.	Plate	22.	Insulator	30.	Shaft
		15.	Plate	23.	Rod	31.	Shaft

FIG. 6 TYPICAL DESIGN OF TYPE A — CRANE ASSEMBLY — Contd

VIEW IN DIRECTION
OF ARROW A

VIEW IN DIRECTION OF ARROW B



ENLARGED SECTION XX

ENLARGED SECTION YY

Part No.	Part Name	Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
32.	Bracket	39.	Spacer	46.	Angle	53.	Plate
33.	Hook	40.	Protractor circle	47.	Angle	54.	L-Section plate
34.	Latch	41.	Protractor circle	48.	Angle	55.	Plate
35.	Wheel with hub	42.	Plate	49.	Angle	56.	Spacer
36.	Spacer	43.	Tube	50.	Plate	57.	Pipe
37.	Cotter pin	44.	Handle	51.	Plate	58.	Bend
38.	Spacer	45.	Bearing	52.	Angle	59.	L-Section plate

FIG. 6 TYPICAL DESIGN OF TYPE A — CRANE ASSEMBLY

- d) The current meter should be securely fixed to the gauging reel, so that there are no chances of its getting loose and lost; and
- e) The gauging reel should be released gradually and not with jerks.

B-2.2 A-Frame and Gauging Reel Suspension Arrangement

B-2.2.1 General Description — The A-frame and gauging reel suspension arrangement may be fixed to the boat easily. A-crane being heavier cannot be conveniently and safely used on boats usually used for observation purposes. Hand line arrangement introduces personal errors. The A-frame arrangement is lighter, and is collapsible and may be folded on the deck when not in use. A general view is shown in Fig. 7 and the whole assembly and details of its various parts are shown in Fig. 8.

B-2.2.1.1 A-frame is an aluminium tubular frame (1) consisting of the following tubes:

- a) Two main boom tubes (1) and (2), about 40 mm in diameter, and 2.2 m long, flattened and bolted at either end.
- b) One central tie rod tube (3), about 40 mm in diameter, and 1.95 m long, welded at both ends.
- c) Two short boom tubes (4) and (5), about 40 mm in diameter and 800 mm long flattened and bolted at one end and welded at the other end.
- d) Two leg tubes (6) and (7), about 40 mm in diameter and 700 mm long flattened at both ends and bolted.

B-2.2.1.2 Assembly and fixing details — Two aluminium angles (8) and (9) about $100 \times 50 \times 3$ mm in size are fastened to the deck of the boat about 600 mm apart with about 10 mm bolt and 3 mm thick, flanges 100 mm and 300 mm wide as shown in Fig. 8. The main tubes (1) and (2) are bolted to these angles and flanges. At the other end, both these tubes are bolted together with 3 mm flanged plate about 150 mm and 60 mm wide in between (10) as shown in Fig. 8. Between these two flanged plates (10), a pulley (11) of about 75 mm diameter is fixed with a bolt of about 6 mm diameter with wooden block washers to suit. The central tie rod tube (3) is welded to this joint. The other end of the central tie rod tube (3) is welded to a joint which holds the second pulley (12). To this joint, the top ends, of the short boom tubes (4) and (5) are bolted with 6 mm bolts. The other ends of the short boom tubes are welded to the main boom tubes (1) and (2) at an angle of 90° .

The leg tubes (6) and (7) are fastened at their one end in the notches in the 3 mm plates with 25 mm flanges fixed to the deck with bolts at a distance of about 650 mm from the other deck joints. Its other upper end is bolted to the main boom tubes (1) and (2) 600 mm away from its deck point joint (for details, see Fig. 8). The A-frame is now completely assembled and fixed.

B-2.2.1.3 Lowering and raising the A-frame — The lower ends of the leg tubes (6) and (7) are taken out from the deck plate notches, and are moved at their other end to come flush with the main boom tubes (1) and (2). The main boom tubes (1) and (2) are then moved at their deck end joint, downwards to rest on wooden chock (13). To raise the assembly, the leg tubes (6) and (7) are again straightened and fixed to the deck plate notch by the bolts.

B-2.2.2 Operation — The gauging reel is carried from its drum (not shown in Fig. 8, but fixed in the centre portion of the boat) to the brass

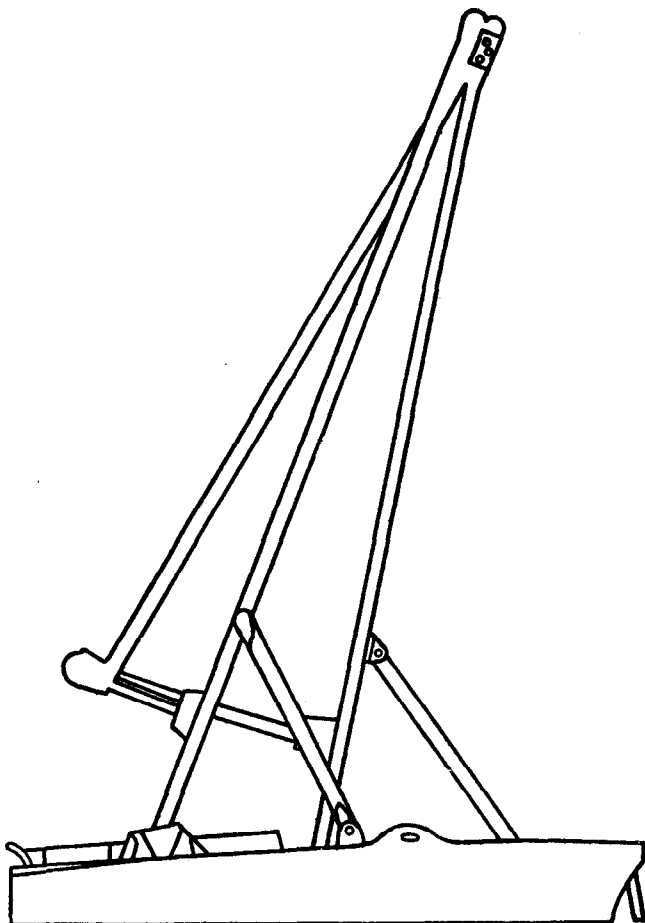
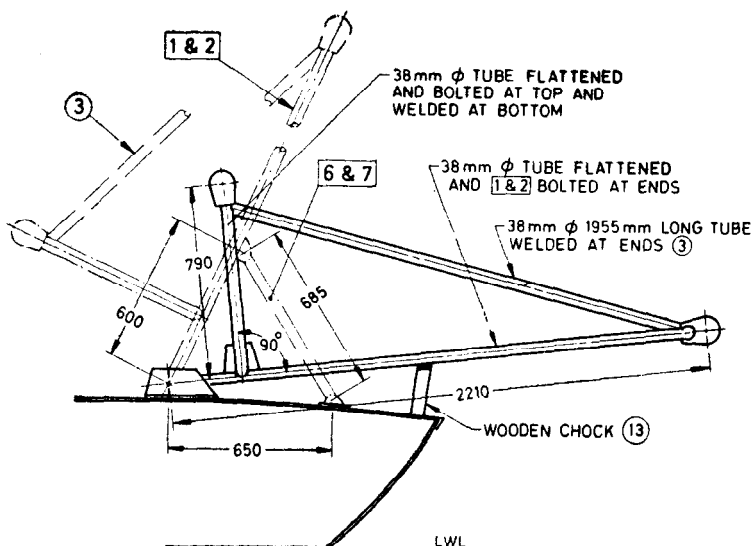
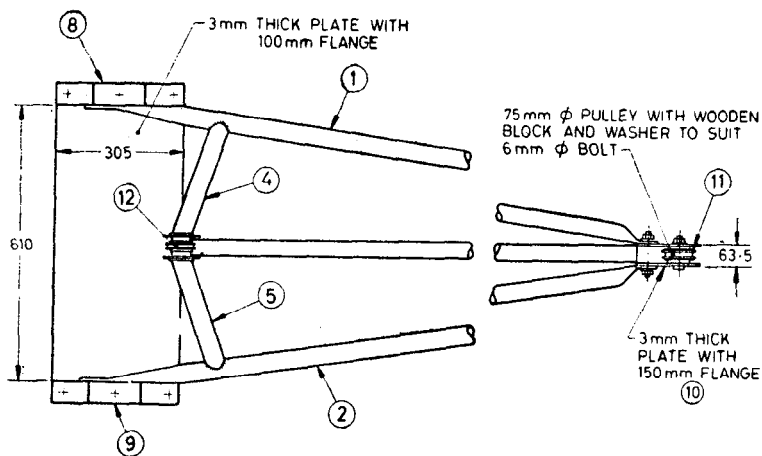


FIG. 7 A-FRAME



A-FRAME WITH ALTERNATE POSITION



ENLARGED DETAIL OF A-FRAME

All dimensions are in millimetres and approximate.

FIG. 8 TYPICAL DETAILS OF A-FRAME

pulley (12) and then to the front brass pulley (11). To this end of the gauging reel, is fixed the shackle to hold the current meter. The gauging reel drum may be rotated either by a handle, or by an electric motor worked with battery. By rotating the drum the current meter is lowered or raised. Suitable weights are attached below the current meter, to keep the reel vertical. The distance to which the current meter is lowered is recorded on the counter attached to the drum.

B-2.2.3 The precautions necessary while using the A-frame and gauging reel are the following:

- a) The A-frame should be in raised position when in use;
- b) It should be brought to resting position when not in use;
- c) The current meter should be securely fixed to the gauging reel, so that there are no chances of its getting loose and lost; and
- d) The gauging reel should be released gradually and not with jerks.

APPENDIX C

(Clause 1.1)

TYPICAL DETAILS OF GAUGING (SOUNDING) REEL

C-1. GENERAL DESCRIPTION

C-1.1 The details of gauging reel (sounding) reel arrangement are shown in Fig. 9. The main parts described in C-1.2 to C-1.7.

C-1.2 Left Hand Bracket (1) — It is made of an aluminium alloy. To this bracket (1), the gauging reel drum (12), the counter for recording the revolutions of the drum and the sheave shaft (7) to carry sheave (19) are fixed as per details given in Fig. 9.

C-1.3 Right Hand Bracket (6) — It is made of an aluminium alloy. To this bracket (6), hollow shaft (7) of the gauging reel drum pawl shaft (11), and sheave shaft (7), are attached as per details given in Fig. 9.

C-1.4 Gauging Reel Drum (12) — It is made of an aluminium alloy, as per details given in Fig. 9. This hollow shaft (17) of the drum and also shaft (16) of the drum are fixed as per details given in Fig. 9. It is on this drum that the gauging reel is wound. The revolutions of this drum are recorded on the counter attached.

C-1.5 Shaft of Gauging Reel Drum (16) — It is made of stainless steel as shown in Fig. 9. This is the main shaft which is rotated either by a handle or a pulley (38) mechanically driven to give rotation to the drum (12). On this shaft (16), hollow shaft (17) and drum (12) are mounted.

This drum assembly is fixed to left hand bracket (1) and right hand bracket (6). Whole assembly details are shown in Fig. 9.

C-1.6 Sheave Shaft and Sheave (7) and (19) — The sheave shaft is made of stainless steel. The sheave (19) is made of aluminium bronze. The sheave shaft (7) is fixed to left hand (1) and right hand (6) brackets as given in detail in Fig. 9. On this shaft (7), the sheave (19) is mounted. On this sheave (19) the gauging reel wire from the drum (12) passes. Its basic function is to keep the coils of gauging reel wire on the drum, evenly spaced and to prevent crowding of several coils at one place.

C-1.7 Gauging Reel Drum Assembly — To the drum shaft (16), a handle to rotate the drum by hand and pulley (38) to rotate the drum mechanically through a belt are attached. A pawl and ratchet arrangement is fixed to right hand bracket side to stop the rotation of the drum at any desired position.

C-1.7.1 Gauging Reel — The gauging reel is generally made of 3.8 mm diameter steel cable with centre insulated conductor. The cable is wound in a single layer on the drum (12). One revolution of the winding handle delivers about 300 mm of cable, the amount unwound being measured on a counter in metres, decimetres and centimetres. A plug socket connects the gauging reel cable to the headphone or current meter counter. Such type of reel is suitable for handling weights up to 35 kg. For heavier weights, stronger wire cable with centre insulated conductor should be used.

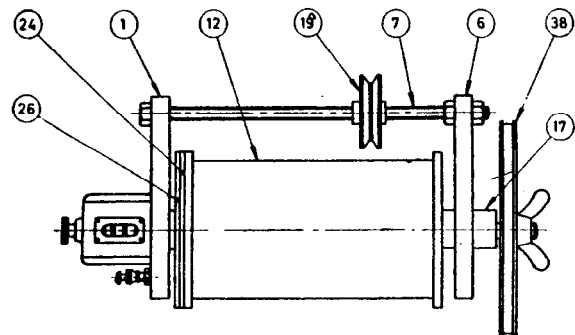
C-2. OPERATION

C-2.1 The gauging reel drum may be rotated either by a handle or by an electric motor worked with battery. A belt connects the pulley (38) to the motor. One end of the reel cable is attached to the battery and current meter counter. To the other end of the cable, a shackle to hold the current meter is fixed. Its conductor wire ends are fixed to the current meter, for recording its revolutions, on the counter or headphone attached at the other end. Suitable weights are attached below the current meter to keep the reel cable vertical. The distance to which the current meter is lowered or raised is recorded on the counter attached to the drum assembly.

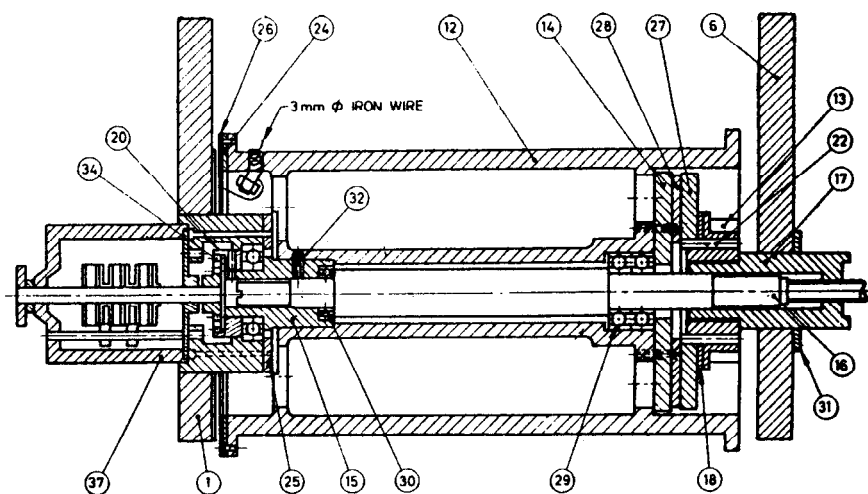
C-3. PRECAUTIONS WHILE USING THE GAUGING REEL

C-3.1 The following are the precautions while using the gauging reel:

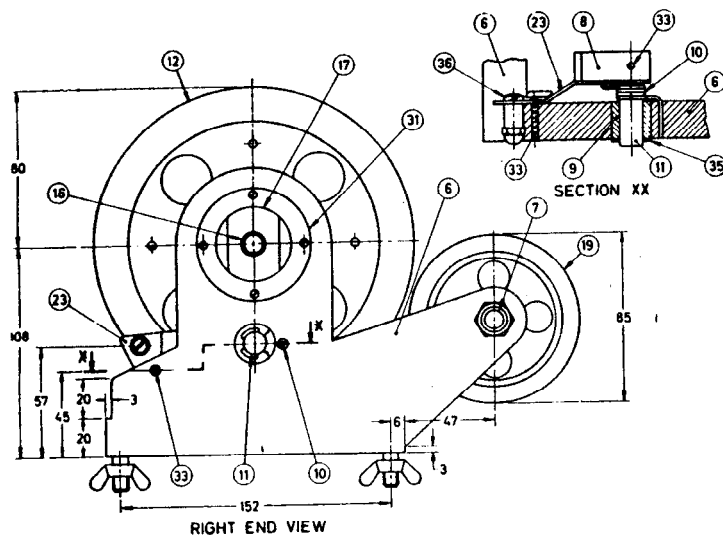
- a) The current meter should be securely fixed to the gauging reel, so that there are no chances of its getting loose and lost;
- b) The gauging reel cable should be released gradually and not with jerks; and
- c) The gauging reel assembly should be securely bolted to the carrier.



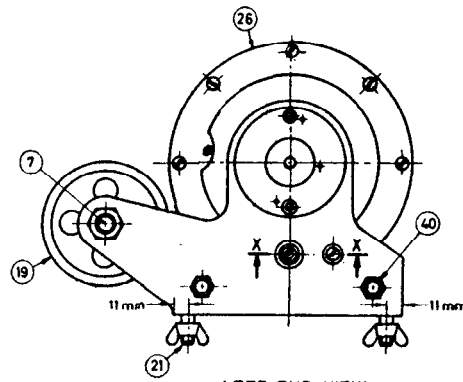
TOP VIEW



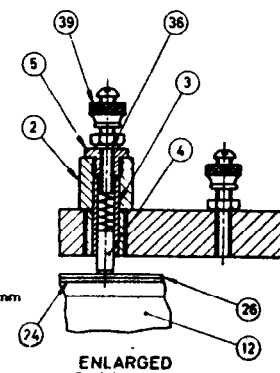
SECTIONAL VIEW OF GAUGING REEL



RIGHT END VIEW



LEFT END VIEW

ENLARGED
SECTION XX

Part No.	Part Name	Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
1.	Left hand bracket	11.	Gauging reel drum pawl shaft	21.	Stud	31.	Bush
2.	Brush holder	12.	Gauging reel drum	22.	Pin	32.	Roll pin
3.	Bushing	13.	Ratchet	23.	Pawl lock	33.	Roll pin
4.	Brush	14.	Thrust disk	24.	Collector ring insulator	34.	Roll pin
5.	Insulator bushing	15.	Bushing	25.	Cover Plate	35.	Retaining ring
6.	Right hand bracket	16.	Gauging reel drum shaft	26.	Collector ring	36.	Lock washer
7.	Sheave shaft	17.	Hollow shaft	27.	Brake plate	37.	Roll pin
8.	Pawl	18.	Washer	28.	Brake lining	38.	Pulley
9.	Pawl bushing	19.	Sheave	29.	Bearing	39.	Knurled nut
10.	Pawl spring	20.	Gear	30.	Bearing	40.	Cap screw

All dimensions are in millimetres and approximate.

FIG. 9 SOUNDING REEL

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Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	{ 331 01 31 331 13 75
*Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	36 24 99
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	{ 2 18 43 3 16 41
Southern : C. I. T. Campus, MADRAS 600113	{ 41 24 42 41 25 19 41 29 16
†Western : Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093	6 32 92 95

Branch Offices:

*Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001	{ 2 63 48 2 63 49
‡Peenya Industrial Area 1st Stage, Bangalore Tumkur Road BANGALORE 560058	{ 38 49 55 38 49 56
Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, BHOPAL 462003	6 67 16
Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002	5 36 27
53/5, Ward No. 29, R.G. Barua Road, 5th Byelane, GUWAHATI 781003	3 31 77
5-8-56C L, N. Gupta Marg (Nampally Station Road), HYDERABAD 500001	23 10 83
R14 Yudhister Marg, C Scheme, JAIPUR 302005	{ 6 34 71 6 98 32
117/418 B Sarvodaya Nagar, KANPUR 208005	{ 21 68 76 21 82 92
Patliputra Industrial Estate, PATNA 800013	6 23 05
T.C. No. 14/1421, University P.O., Palayam TRIVANDRUM 695035	{ 6 21 04 6 21 17

Inspection Offices (With Sale Point):

Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010	2 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	5 24 35

*Sales Office in Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, Calcutta 700072

†Sales Office in Bombay is at Novelty Chambers, Grant Road, 89 65 28 Bombay 400007

‡Sales Office in Bangalore is at Unity Building, Narasimharaja Square, 22 36 71 Bangalore 560002